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To Mr. F.J. Kee
Director of Research

A REVISED USER'S MANUAL TO ESTIMATE CONFIDENCE INTERVALS AND SAMPLE SIZES, AND TO PRODUCE SINGLE SAMPLING PLANS

C.J. Schwarz

A computer program has been written a) to estimate confidence intervals for the population mean of a normal distribution, the population proportion in a binomial distribution and the population total in a hypergeometric distribution (the most often used parameters in investigations); b) to determine sample sizes required for estimating the population proportion in a binomial distribution or the population mean in a normal distribution to a given precision; and c) to produce single sampling plans for quality control. The user is prompted by the computer for the necessary information. This is a revision of manual (Research Division Report 82-402-K) issued on September 23, 1982.

1. INTRODUCTION

The previous manual (Research Division Report 82-402-K) was revised to accommodate a change in computer language (FORTRAN to APL). The new computer code will save the user both time and money.

This report describes a computer program prepared to perform the following calculations:

- Determination of confidence intervals for the population mean from a normal distribution.
- Determination of confidence intervals for the population proportion in a binomial distribution.
- Determination of confidence intervals for the population total in a hypergeometric distribution.

job	file	date	report no.
740672-510-033	809.7	January 11, 1985	84-433-K

- Determination of the sample size necessary to find the mean of a normal population to a given precision.

- Determination of the sample size necessary to find the population proportion to a given precision in a binomial distribution.

- Production of single sampling plans for quality control.

The computer program is available on the IBM computer system under VS APL. The user is prompted by the program for the necessary information; this will be illustrated by several examples. Input is freeform; ie, numbers do not have to be in specific columns but need only to be separated by at least 1 blank.

References 1 and 2 explain the theory behind the computer program.

2. ACCESSING THE PROGRAM

The user must first sign on to the IBM computer system and invoke VS APL. The Computer Services Unit of the Research Division could be consulted for information on this procedure.

To execute the program the user should load the sampling workspace by typing:

```
>LOAD SAMPLING
```

A latent function will then execute the function DESCRIBE which will list the available functions and any comments. See Figure 1 for an example of the output from the DESCRIBE function. The workspace is completely documented. As described by the DESCRIBE function, this documentation is available by executing the appropriate function as shown in Figures 1, 2, 3 and 4.

3. CONFIDENCE INTERVALS

Confidence intervals for the population mean from a normal distribution, the population proportion from a binomial distribution, or the population total from a hypergeometric distribution may be found by using the procedures outlined in Figures 2 and 3.

The confidence interval is a measure of the reliability of the estimate of the parameter. A wide interval means that the estimate is not very precise; a narrow interval means that the estimate is precise. Technically, a $(1-\alpha)$ confidence interval for the parameters means that the probability of observing the actual data given that the parameter takes a value from the confidence interval is greater than α. For example, suppose that in a population of 500 items, 100 were selected and 37 were found to be defective. A 95% ($\alpha = 0.05$) confidence interval for the number defective is (142,228) from Figure 2. If the actual number of defective (which is unknown)

falls within this interval, then the probability of observing 37 defectives in a sample size of 100 is greater than 5%, ie, it is 95% certain that the true number of defectives lies between 142 and 228.

3.1 Normal Distribution

Figures 5, 6 and 7 illustrate the documentation and use of the workspace in finding a 95% confidence interval for the mean of a normal distribution. The points listed below correspond to the points in Figure 7.

1. The user indicates that a confidence interval for the mean of a normal distribution is to be found.

2. The user enters the sample size, sample mean, sample standard deviation, confidence level desired and the type of confidence limit desired (either lower or upper or both).

3. The results are printed.

4. A new round is started, but the user may elect to exit from the function.

3.2 Hypergeometric Distribution

Figures 8, 9 and 10 illustrate the use of the workspace in finding a confidence interval for the population total from a hypergeometric distribution. The points listed below correspond to the points in Figure 10.

1. The user indicates that a confidence interval for the population total in a hypergeometric distribution is to be found.

2. The user enters the population size, the sample size, the defectives found, the confidence level desired and the type of confidence limit desired (either lower or upper or both).

3. The results are printed.

4. A new round is started, but the user may elect to exit from the function.

3.3 Binomial Distribution

Figures 11, 12 and 13 illustrate the use of the workspace in finding a confidence interval for the population proportion and total from a binomial distribution. The points listed below correspond to the points in Figure 13.

1. The user indicates that a confidence interval for the population proportion in a binomial distribution is to be found.

2. The user enters the population size (if a confidence interval for the population total is desired; else enter 0), the sample size, the number of successes found, the confidence level, and the type of confidence limit desired (either lower or upper or both).

3. The results are printed.

4. A new round is started, but the user may elect to exit from the function.

4. SAMPLE SIZES

The program will calculate the sample size necessary to estimate the population mean in a normal distribution, or the population proportion in a binomial distribution with a pre-defined confidence interval size stated as an absolue quantity (eg ±5). Figures 14, 15 and 16 illustrate how to use the program.

The results will give the user an indication of how much effort will be needed to obtain a reliable estimate of a parameter. The task is the converse of the case in the previous section where the sample size was fixed and a confidence interval was determined. In this case, the width of the confidence interval is fixed before hand, and the sample size needed to obtain such a confidence interval is determined.

4.1 Binomial Distribution

Figure 15 illustrates how to find the sample size needed to determine the population proportion in a binomial distribution within 5 percentage points, 95% of the time (ie the 95% confidence interval will be ±5%). The points listed below correspond to the points in the Figure.

1. The user indicates that sample sizes to estimate a binomial proportion are to be found.

2. The user enters the absolute error.

3. The user enters the risk level (1 - confidence level).

4. The user enters an advanced estimate of the population proportion and the sample size.

5. The results are printed.

6. A new round is started but the user may elect to exit from the function.

4.2 Normal Distribution

Figure 16 illustrates how to find the necessary sample size to determine the mean of a normal distribution within 1 unit of its value, 95% of the time, ie, how big a sample needs to be taken so that the 95% confidence interval for the mean will be ±1 unit wide. The points listed below correspond to the points in the Figure.

1. The user indicates that sample sizes to estimate the mean from a normal distribution are to be found.

2. The user enters the absolute margin of error, that a 95% confidence interval is to be used (5% risk of exceeding error margin), and an estimate of the standard deviation.

3. The results are printed.

4. A new round is started but the user may elect to exit from the function.

5. SINGLE SAMPLING PLANS

The workspace may be used to determine optimal single sampling plans. Figure 17 illustrates the documentation of this function and how the function may be used. The points listed below correspond to the points in Figure 17. For a detailed explanation of single sampling plans, see reference 2.

1. The user indicates that single sampling plans are to be produced.

2. The user enters the lot size, the allowable defectives, and the consumer risk.

3. The user enters the average defective rate.

4. A plan is printed.

Approved:

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REFERENCES

1. Cochran, W.G. (1963) Sampling Techniques (2nd Ed) Howard V. Press, Cambridge, Mass., U.S.A.

2. Dodge, H.F.I., Romig, H.G. (1959) Sampling Inspection Tables: Single and Double Sampling, John Wiley and Sons, New York, U.S.A.

```
      DESCRIBE
THIS WORKSPACE CONTAINS FUNCTIONS USED IN SAMPLING.
THE FUNCTIONS AVAILABLE AND THEIR DESCRIPTION ARE

      DESCRIBE              THIS DESCRIPTION

      HYPER∆CI∆INT          INTERACTIVE HYPERGEOMETRIC CONFIDENCE INTERVALS
      HYPER∆CI              NON-INTERACTIVE VERSION OF ABOVE

      BINOM∆CI∆INT          INTERACTIVE BINOMIAL CONFIDENCE INTERVALS
      BINOM∆CI∆EXACT        EXACT NON-INTERACTIVE VERSION
      BINOM∆CI∆APPROX       APPROXIMATE NON-INTERACTIVE VERSION

      NORM∆CI∆INT           INTERACTIVE NORMAL CONFIDENCE INTERVALS
      NORM∆CI               NON-INTERACTIVE VERSION

      SAMP∆SIZE∆INT         INTERACTIVE SAMPLE SIZE CALCULATIONS
      SING∆SAMP∆LQT∆INT     INTERACTIVE SINGLE SAMPLE LOT QUALITY
                            PROTECTION PLANS

A DESCRIPTION OF HOW TO USE THESE ROUTINES MAY BE FOUND BY EXECUTING
THE FUNCTION NAMED BY 'DESCRIBE∆' CATENATED WITH THE FUNCTION
NAME, E.G.  DESCRIBE∆HYPER∆CI∆INT    DESCRIBES  HYPER∆CI∆INT

THERE ARE ADDITIONAL FUNCTIONS THAT DESCRIBE PARTICULAR FEATURES:

      HOW∆ENTER∆CI          - HOW TO ENTER THE CONFIDENCE LEVEL
      HOW∆ENTER∆CI∆TYPE     - HOW TO ENTER THE CONFIDENCE INTERVAL TYPE
      HOW∆EXIT              - HOW TO EXIT FROM A FUNCTION

IF YOU HAVE ANY QUESTIONS ABOUT THIS WORKSPACE, OR FOR MORE
INFORMATION ABOUT ADVANCED FEATURES OF THIS WORKSPACE,  CONTACT:

                A.L. Punhani
                Statistics Unit
                Operations Research Department
                KR297    122+6552

**********  WARNING  **********

BINOMIAL CONFIDENCE INTERVAL ROUTINE ARE BEING ADJUSTED AND ARE
NOT CURRENTLY AVAILABLE
```

Figure 1: DESCRIBE Function

```
HOWΔENTERΔCI
THE CONFIDENCE LEVEL IS ENTERED AS A FRACTION BETWEEN 0 AND 1, F.G.
TO OBTAIN A 95 PERCENT CONFIDENCE INTERVAL, YOU WOULD ENTER .95
```

FIGURE 2: HOW Δ ENTER Δ CI

```
HOWΔENTERΔCIΔTYPE
THERE ARE THREE DIFFERENCE CONFIDENCE INTERVAL TYPES, LOWER ONLY,
TWO SIDED, AND UPPER ONLY.  SUPPOSE THAT YOU REQUESTED A 95 PERCENT
CONFIDENCE INTERVAL.

IF YOU REQUEST A LOWER CONFIDENCE BOUND, YOU WILL BE 95 PERCENT
SURE THAT THE TRUE POPULATION VALUE IS ABOVE THE LOWER BOUND.
NO STATEMENT MAY BE MADE ABOUT THE UPPER BOUND. A LOWER CONDFIDENCE
BOUND IS REQUESTED BY TYPING  10  WHEN EVER YOU ARE REQUESTED TO
ENTER THE CONFIDENCE INTERVAL TYPE

IF YOU REQUEST AN UPPER CONFIDENCE BOUND, YOU WILL BE 95 PERCENT
SURE THAT THE TRUE POPULATION VALUE IS BELOW THE UPPER BOUND.
NO STATEMENT MAY BE MADE ABOUT THE LOWER BOUND.  AN UPPER CONFIDENCE
BOUND IS REQUESTED BY TYPING  01  WHEN EVER YOU ENTER THE CONFIDENCE
INTERVAL TYPE

IF YOU REQUEST A TWO SIDED CONFIDENCE BOUND, YOU WILL BE 95 PERCENT
SURE THAT THE TRUE POPULATION VALUE IS BETWEEN THE LOWER AND UPPER
BOUND.  THERE IS 2.5 PERCENT RISK THAT THE TRUE POPULATION VALUE
IS EITHER ABOVE THE UPPER BOUND, OR BELOW THE LOWER BOUND.  NOTE, THA
SOMETIMES IT IS IMPOSSIBLE TO CONSTRUCT A TWO SIDED CONFIDENCE INTEVA
WITH THE RISKS EQUALLY SPLIT AS ABOVE.  IN THESE CASES, THE INTERVAL
IS SHIFTED SO THAT MORE OF THE RISK OCCURS EITHER ABOVE THE UPPER
BOUND OR BELOW THE LOWER BOUND.  IN ALL CASES, THE INTERVAL IS STILL
A 95 PERCENT CONFIDENCE INTERVAL.  A TWO SIDED CONFIDENCE BOUND
IS REQUESTED BY TYPING  11  WHEN EVER YOU ENTER THE CONFIDENCE
INTERVAL TYPE.
```

FIGURE 3: HOW Δ ENTER Δ CI Δ TYPE

```
      ΔEXIT
H OF THE INTERACTIVE FUNCTION WILL RETURN TO THE BEGINNING
 THE FUNCTION AND START OVER AT THE END OF THE CALCULATIONS.
 YOU WISH TO CONTINUE, JUST ENTER THE NEW VALUES AND THE PROGRAM
L REPEAT.  IF YOU WISH TO EXIT, THEN TYPE A RIGHT POINTING
OW (→), FOLLOWED BY ENTER,  OR, TYPE THE FUNCTION  STOP  FOLLOWED
 ENTER
```

FIGURE 4: HOW Δ EXIT

```
DESCRIBEΔNORMΔCIΔINT
THIS FUNCTION IS USED TO CALCULATE CONFIDENCE LIMITS FOR THE MEAN
WHEN A SAMPLE IS TAKEN FROM A NORMAL POPULATION.  THE FUNCTION WILL
PROMPT YOU TO ENTER THE SAMPLE SIZE, THE SAMPLE MEAN, THE SAMPLE
STANDARD DEVIATION, THE CONFIDENCE LEVEL, AND THE TYPE OF CONFIDENCE
INTERVAL THAT YOU WANT.
-------------------------------------------------------------------
FOR FURTHER INFORMATION ABOUT ENTERING THE INPUT VALUES USE THE
FOLLOWING FUNCTIONS:

     HOWΔENTERΔCI          - HOW TO ENTER THE CONFIDENCE LEVEL
     HOWΔENTERΔCIΔTYPE     - HOW TO ENTER THE CONFIDENCE INTERVAL TYPE
     HOWΔEXIT              - HOW TO EXIT

-------------------------------------------------------------------
```

FIGURE 5: DESCRIBE Δ NORM Δ CI Δ INT

```
      DESCRIBEΔNORMΔCI
THIS FUNCTION IS THE NON-INTERACTIVE VERSION OF  NORMΔCIΔINT.
YOU WILL NOT NEED TO USE THIS FUNCTION UNLESS YOU ARE IMBEDDING
THIS IN ANOTHER APPLICATION.

IF YOU HAVE ANY QUESTIONS ABOUT THIS WORKSPACE, OR FOR MORE
INFORMATION ABOUT ADVANCED FEATURES OF THIS WORKSPACE,  CONTACT:

          A.L. Punhani
          Statistics Unit
          Operations Research Department
          KR297       122+6552
```

FIGURE 6: DESCRIBE Δ NORM Δ CI

```
      NORMΔCIΔINT
ENTER SAMPLE SIZE, SAMPLE MEAN, SAMPLE STD. DEV., CONFIDENCE LEVEL
AND TYPE OF CONFIDENCE INTERVAL(10=LOWER ONLY, 11=TWO SIDED, 01=UPPER ONLY)
TO TERMINATE THE REQUESTS, ENTER AN →
0:
      10 0 10 .95 11

SAMPLE SIZE WAS                 :          10
OBSERVED SAMPLE MEAN WAS        :           0
OBSERVED SAMPLE STD. DEV WAS    :          10
CONFIDENCE LEVEL                :      .95000

THIS IS A TWO SIDED CONFIDENCE INTERVAL

POINT ESTIMATE OF MEAN          :           0
LOWER     .950 BOUND ON MEAN    :-22.62759963
UPPER     .950 BOUND ON MEAN    :22.62759963

ENTER SAMPLE SIZE, SAMPLE MEAN, SAMPLE STD. DEV., CONFIDENCE LEVEL
AND TYPE OF CONFIDENCE INTERVAL(10=LOWER ONLY, 11=TWO SIDED, 01=UPPER ONLY)
TO TERMINATE THE REQUESTS, ENTER AN →
0:
      →
```


FIGURE 7: NORM Δ CI Δ INT

```
      DESCRIBEΔHYPERΔCIΔINT
THIS FUNCTION WILL CALCULATE CONFIDENCE INTERVALS WHEN SAMPLING
FROM A HYPERGEOMETRIC DISTRIBUTION.  THIS USUALLY OCCURS WHEN
SAMPLING WITHOUT REPLACEMENT OCCURS.  NOTE THAT IF THE POPULATION
SIZE IS LARGE AND THE SAMPLING FRACTION IS SMALL, CONFIDENCE INTERVAL
CALCULATED USING THE BINOMIAL DISTRIBUTION WILL BE QUITE ACCURATE
AND IS CONSIDERABLY CHEAPER AND QUICKER TO USE.

TO USE THIS FUNCTION, YOU SIMPLY TYPE THE FUNCTION NAME.  YOU WILL
BE PROMPTED TO ENTER THE POPULATION SIZE, THE SAMPLE SIZE,
THE NUMBER OF DEFECTIVES IN THE SAMPLE, THE CONFIDENCE LEVEL
THAT YOU REQUIRE, AND THE TYPE OF CONFIDENCE INTERVAL THAT YOU WANT.
EACH OF THE ENTRIES SHOULD BE SEPARATED BY AT LEAST ONE BLANK
-------------------------------------------------------------------
FOR MORE INFORMATION ON HOW TO ENTER THE INPUT VALUES, USE THE
FOLLOWING FUNCTIONS:

  HOWΔENTERΔCI              - HOW TO ENTER THE CONFIDENCE LEVEL
  HOWΔENTERΔCIΔTYPE         - HOW TO ENTER THE CONFIDENCE INTERVAL TYPE
  HOWΔEXIT                  - HOW TO EXIT FROM THE PROGRAM

-------------------------------------------------------------------
```

FIGURE 8: DESCRIBE Δ HYPER Δ CI Δ INT

```
DESCRIBEΔHYPERΔCI
THIS FUNCTION IS THE NON-INTRACTIVE VERSION OF  DESCRIBEΔHYPERΔCIΔINT
THE ORDINARY USER WILL NOT NEED TO USE THIS FUNCTION UNLESS IT IS
BEING IMBEDDED IN ANOTHER SYSTEM.
USE  HYPERΔCIΔINT  AND  DESCRIBEΔHYPERΔCIΔINT  FOR MORE DETAILS.

IF YOU HAVE ANY QUESTIONS ABOUT THIS WORKSPACE, OR FOR MORE
INFORMATION ABOUT ADVANCED FEATURES OF THIS WORKSPACE,  CONTACT:

          A.L. Punhani
          Statistics Unit
          Operations Research Department
          KR297      122+6552
```

FIGURE 9: DESCRIBE Δ HYPER Δ CI

```
HYPERΔCIΔINT
INPUT POP. SIZE, SAMPLE SIZE, DEFECTIVES, CONFIDENCE LEVEL AND
TYPE OF CONF.INTERVAL(10=LOWER ONLY, 11=TWO SIDED, 01=UPPER ONLY)
IF NO MORE CALCULATIONS ARE REQUIRED, ENTER A →
□:
      1000 70 7 .95 11

POPULATION SIZE   :        1000
SAMPLE     SIZE   :          70
SAMPLE DEFECTIVES:           7
CONFIDENCE LEVEL  :        .950

TWO SIDED CONFIDENCE INTERVAL WILL BE FOUND

POINT ESTIMATE OF POPULATION DEFECTIVES IS:          100

LOWER    .950 BOUND IS:          42
UPPER    .950 BOUND IS:         191

PR( ≥ 7 DEF. IN SAMPLE | 42 DEF. IN THE POPULATION ) =        .0227

PR( ≤ 7 DEF. IN SAMPLE | 191 DEF. IN THE POPULATION ) =       .0262

ACTUAL CONFIDENCE INTERVAL SIZE=       .9511


INPUT POP. SIZE, SAMPLE SIZE, DEFECTIVES, CONFIDENCE LEVEL AND
TYPE OF CONF.INTERVAL(10=LOWER ONLY, 11=TWO SIDED, 01=UPPER ONLY)
IF NO MORE CALCULATIONS ARE REQUIRED, ENTER A →
□:
      →
```

FIGURE 10: EXAMPLE OF HYPER Δ CI Δ INT

DescribeΔbinomΔciΔint

This must be created in the workspace.

- This will be similar to describe hyperΔciΔint except for the binomial distribution.
- Use DescribeΔhyperΔciΔint as a guide to create for this function

FIGURE 11: DESCRIBE Δ BINOM Δ CI Δ INT

DescribeΔbinomΔci

- Modify DescribeΔhyperΔci appropriately.
- This must be created in the workspace.

IF YOU have any questions about this workspace, or for more information about advanced features of this workspace, contact:

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Statistics Unit
Operations Research Department
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FIGURE 12: DESCRIBE Δ BINOM Δ CI

```
BINOMΔCIΔINT

ENTER POP. SIZE, SAMPLE SIZE, NUMBER FOUND, CONFIDENCE LEVEL
IF POPULATION SIZE IS NOT BE USED, ENTER A 0 FOR IT.
IF YOU WANT TO EXIT TYPE →
□:
      0 10 4 .9

POPULATION SIZE      :          0
SAMPLE SIZE          :         10
SUCCESSES IN SAMPLE  :          4
CONFIDENCE LEVEL     :       .900

POINT ESTIMATE OF POP. PROPORTION AND TOTAL     : .40000          0

LOWER  .900 BOUND ON POP. PROPORTION AND TOTAL : .15003          0
UPPER  .900 BOUND ON POP. PROPORTION AND TOTAL : .69646          0

PR( ≥ SUCCESSES GIVEN LOWER BOUND ) :  .05000
PR( ≤ SUCCESSES GIVEN UPPER BOUND ) :  .05000

ACTUAL CONFIDENCE INTERVAL SIZE =      .9000


ENTER POP. SIZE, SAMPLE SIZE, NUMBER FOUND, CONFIDENCE LEVEL
IF POPULATION SIZE IS NOT BE USED, ENTER A 0 FOR IT.
IF YOU WANT TO EXIT TYPE →
□:
      →
```


FIGURE 13: EXAMPLE OF BINOM Δ CI Δ INT

```
DESCRIBE△SAMP△SIZE△INT
THIS FUNCTION WILL HELP YOU CALCULATE YOUR MINIMAL SAMPLE SIZE
WHEN ESTIMATING:
     1. THE PROPORTING IN BINOMIAL SAMPLING
     2. THE MEAN FROM A NORMAL DISTRIBUTION

THE FUNCTION PROMPTS YOU FOR ALL THE NECESSARY INPUTS.

IF YOU WISH SAMPLING PLANS FOR QUALITY CONTROL SEE
THE FUNCTION    SING△SAMP△LQT△INT
```

FIGURE 14: DESCRIBE Δ SAMP Δ SIZE Δ INT

```
      SAMP∆SIZE∆INT
YOU MAY ESTIMATE THE NUCESSARY SAMPLE SIZE FOR THE FOLLOWING CASES

    1. ESTIMATE THE PROPORTION USING BINOMIAL SAMPLINE
    2. ESTIMATE THE MEAN FROM A NORMAL DISTRIBUTION

ENTER THE NUMBER OF THE CASE DESIRED
TO EXIT FROM THE PROGRAM, TYPE A →
0:
      1
ENTER ABSOLUTE MARGIN OF ERROR
ENTER A → TO EXIT FROM PROGRAM
0:
      .05
ENTER RISK THAT ACTUAL ERROR WILL EXCEED       .05000
0:
      .05
ENTER ESTIMATE OF ACTUAL PROPORTION AND POPULATION SIZE
IF ADVANCED ESTIMATE IS UNKNOWN, USE .5
0:
      .5 10000

POPULATION SIZE              :10000

ADVANCED ESTIMATE OF P     :     .50000
ACCEPTABLE MARGIN OF ERROR:     .05000

RISK OF EXCEEDING ERROR  :     .05000 OR       5.000 PERCENT

RECOMMENDED SAMPLE SIZE IS 371 OR ABOUT     3.71 PERCENT OF THE POPULATION

BINOM∆CI∆INT MAY BE USED TO EXPLORE AROUND THIS REGION


ENTER ABSOLUTE MARGIN OF ERROR
ENTER A → TO EXIT FROM PROGRAM
0:
      →
```

FIGURE 15: EXAMPLE OF SAMP Δ SIZE Δ INT USING BINOMIAL DISTRIBUTION

```
      SAMPΔSIZEΔINT
YOU MAY ESTIMATE THE NUCESSARY SAMPLE SIZE FOR THE FOLLOWING CASES

    1. ESTIMATE THE PROPORTION USING BINOMIAL SAMPLINE
    2. ESTIMATE THE MEAN FROM A NORMAL DISTRIBUTION

ENTER THE NUMBER OF THE CASE DESIRED
TO EXIT FROM THE PROGRAM, TYPE A →
□:
      2
ENTER ABSOLUTE MARGIN OF ERROR (+/- VALUE),
ACCEPTABLE RISK OF EXCEEDING THIS MARGIN, AND AND ESTIMATE
OF THE STANDARD DEVIATION
□:
      1 .05 10

ACCEPTABLE MARGIN OF ERROR     :1

ESTIMATED STANDARD DEVIATION   :10

ACCEPTABLE RISK OF EXCEEDING ERROR BOUND       .05000

RECOMMENDED SAMPLE SIZE IS AT LEAST 385

ENTER ABSOLUTE MARGIN OF ERROR (+/- VALUE),
ACCEPTABLE RISK OF EXCEEDING THIS MARGIN, AND AND ESTIMATE
OF THE STANDARD DEVIATION
□:
      →
```

FIGURE 16: EXAMPLE OF SAMP Δ SIZE Δ INT USING NORMAL DISTRIBUTION

```
SINGΔSAMPΔLOTΔINT


ENTER LOT SIZE, ALLOWABLE DEFECTIVES, CONSUMER RISK
ENTER A → TO END THE PROGRAM
□:
      1000 30 .10
DO YOU KNOW THE AVERAGE DEFECTIVE RATE? (Y/N):Y
ENTER AVERAGE DEFECTIVE RATE
□:
      .0045

SINGLE SAMPLE LOT QUALITY PROTECTION PLANS

LOT SIZE                          :       1000
MAXIMUM ALLOWABLE DEFECTIVES:             30
AVERAGE DEFECTIVE RATE            :   .004500 OR       .4500 PERCENT

CONSUMER RISK                     :   .100000 OR     10.0000 PERCENT


OPTIMAL SAMPLING PLAN IS

SAMPLE SIZE               :        167
ACCEPTANCE NUMBER         :          2

ACTUAL CONSUMER RISK      :      .0985
ACTUAL PRODUCER RISK      :      .0407

AVERAGE SAMPLE SIZE       :      201.9

DO YOU WANT A TABLE AROUND THE OPTIMUM? (Y/N):Y
     SAMPLE     ACCEPT.  CONSUMER   PRODUCER    AVERAGE
       SIZE     NUMBER       RISK       RISK     SAMPLE
         76          0    .09878    .29020      345.1
        123          1    .09804    .10684      217.7
        167          2    .09847    .04070      201.9
        208          3    .09944    .01531      221.1
        248          4    .09865    .00577      253.3
        286          5    .09935    .00212      288.5
        323          6    .09994    .00077      324.5
        360          7    .09880    .00028      361.2
        396          8    .09819    .00010      397.1
        431          9    .09824    .00004      432.0


ENTER LOT SIZE, ALLOWABLE DEFECTIVES, CONSUMER RISK
ENTER A → TO END THE PROGRAM
□:
      →
```

FIGURE 17: EXAMPLE OF DESCRIBE Δ SING Δ SAMP Δ LOT Δ INT

POOR

QUALITY

ORIGINAL